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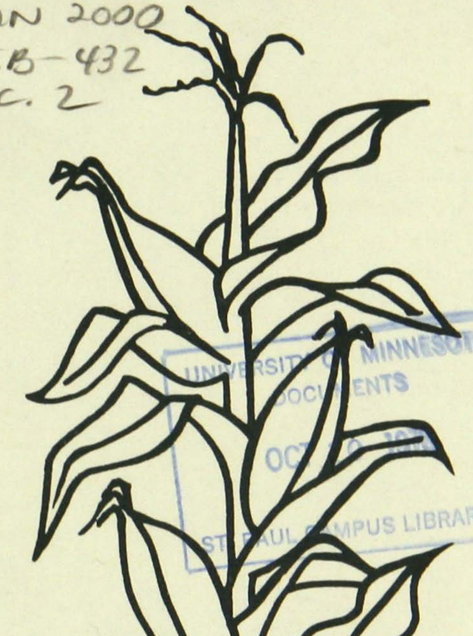

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Pocket Guide to FERTILIZER RECOMMENDATIONS

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Pocket Guide to FERTILIZER RECOMMENDATIONS

R.P. Schoper, C.J. Overdahl, and C.A. Simkins*

Introduction

Soil analysis with today's equipment is relatively simple, but University of Minnesota soil scientists have years of experience in background field experiments and research in soil chemistry.

The costly research is justified because annual fertilizer use in Minnesota exceeds 550,000 tons of N, 320,000 tons P_2O_5 and 360,000 tons of K_2O. Monetary returns on this investment usually are 2 or 3 fold.

This publication provides farmers with information on the use of fertilizer and soil amendments based on the most recent experimental evidence. The authors intend that these recommendations predict the nutrient requirements of plants for maximum economical yields.

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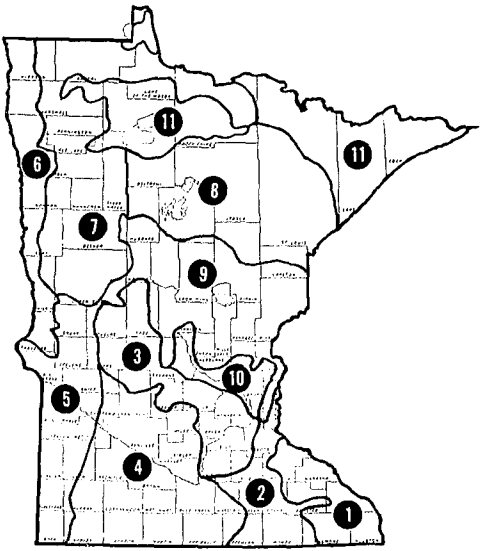
Map 1. Average phosphorus (P) and potassium (K) fertility status of Minnesota's major soil types



Soil area	Phosphorus level	Potassium level
1	Medium-high	Medium
2	Medium	Low-medium
3	Medium-high	Medium
4	Low-medium	Medium
5	Low	High
6	Low-medium	High
7	Low-medium	Low-medium
8-11	High	Low

General Fertility Guide

Relative level	Soil test (lbs/A) P	K
low	0-10	0-100
medium	11-20	101-200
high	21-30	201-300
very high	over 30	over 300

Fertilizer Recommendations

ALFALFA

Fertilization Pointers

- Test soil to determine lime, phosphorus, potassium, and sulfur needs.
- Apply enough fertilizer to bring soil to a high fertility level at seeding.

- Apply enough fertilizer each year to maintain soils at high fertility.
- For new seedings, phosphorus, potassium, sulfur, and lime should be applied as needed and mixed with the top 6 inches of soil.
- On established stands, phosphorus and potassium should be top-dressed in the fall or following the first cutting.
- In area 9 and 10 boron applied at the rate of 2-4 pounds per acre will eliminate boron deficiency.

Table 1. Phosphorus and potassium fertilizer recommendations at seeding time

Nutrient	Soil fertility level			
	Low	Medium	High	Very high
	lbs/A			
Phosphorus — P_2O_5	80	60	20	0
Potassium — K_2O	240	160	40	0

Table 2. Phosphorus and potassium fertilizer recommendations for established stands of alfalfa

Nutrient	Soil fertility level			
	Low	Medium	High	Very high
	lbs/A			
Phosphorus — (P_2O_5)	60	40	30	0
Potassium — (K_2O)	180	120	60	0

CORN

Fertilization Pointers

- Test soils to determine fertility status. Soils testing very high do not need further P (phosphorus) and K (potassium) broadcast applications.
- If soils are slow to warm up, use starter fertilizer to insure P and K supply.
- Add nitrogen according to yield goal. "Rule of Thumb" — 1 pound of N (nitrogen) for each bushel expected.

Table 3. Phosphorus and potassium fertilizer recommendations for corn with a yield potential greater than 100 bushels per acre

Nutrient	Soil fertility level			
	Low	Medium	High	Very high
	lbs/A			
Phosphorus — P_2O_5*	100	80	60	30
Potassium — K_2O*	160	130	100	30

*30 pounds P_2O_5 and 30 pounds K_2O should be applied as starter if the soil tends to warm up late in the spring, if only small amounts are required, or when the yield goal is less than 100 bushels per acre.

Table 4. Nitrogen recommendations*

Yield goal	Amount of nitrogen (N) to apply when the previous crop was: Corn, sugar-beets	Soybeans, potatoes, small grain	Poor alfalfa or clover, black fallow	Good alfalfa or clover
	---------- lbs/A ----------			
161-200 bu/A, over 24 T/A	210	180	150	100
130-160 bu/A 20-24 T/A	180	160	130	80
101-129 bu/A or 16-20 T/A	130	110	80	30
70-100 bu/A 10-15 T/A	80	60	40	15
Less than 70 bu/A or 10 T/A	50	50	15	15

*Although some nitrogen is desirable when row fertilizer is used, high rates of starter nitrogen are not essential.

WHEAT, BARLEY, OATS

Fertilization Pointers

- In low rainfall areas or seeding during very dry conditions, do not exceed 40 pounds $N+K_2O$ per acre in the row.
- If small grain is a companion crop for a legume hay, do not exceed 30 pounds N per acre. If the recommended fertilizer for alfalfa establishment is broadcast (table 1) the P_2O_5 and K_2O recommendation for small grain may be omitted.
- Caution: Urea forms of nitrogen should not exceed 10 pounds nitrogen per acre in the row.
- Retest soils for P and K once every 3 years. In western Minnesota, a 0-24 inch sample for nitrates each year will improve the accuracy of nitrogen recommendations (map 2).

Table 5. Phosphorus and potassium recommendations for small grain

Nutrient	Soil fertility level			
	Low	Medium	High	Very high
	lbs/A			
Phosphorus — P_2O_5	60	40	30	20
Potassium — K_2O	60	30	15	0

Table 6. Nitrogen recommendations for small grain

Previous crop	Amount of nitrogen to apply on current crop (lbs/A)	
	Barley and oats	Wheat
Corn, sugarbeets	60	90
Small grain, soybeans	40	70
Black fallow, alfalfa, organic soil	20	20

SOYBEANS

Fertilization Pointers

- Omit nitrogen unless small amounts such as 10 or 15 pounds per acre are used with P and K in the row.
- Fertilize soils when levels of P and K are low to medium.
- Inoculate soybeans where they have not been grown recently.
- Consider liming if the soil pH is below 6.0.

Table 7. Phosphorus and potassium recommendations for soybeans

Nutrient	Soil fertility level			
	Low	Medium	High	Very high
	---------- lbs/A ----------			
Phosphorus — P_2O_5	90	60	30	0
Potassium — K_2O	100	75	25	0

SUGARBEETS

Fertilization Pointers

- Sugarbeet seeds and seedlings are sensitive to fertilizer salts and germination damage may occur if N and K fertilizer materials contact the seed.
- Due to the effect of nitrogen on sugar percentage and quality, avoid excess use of nitrogen fertilizer. The accuracy of nitrogen recommendations can be greatly improved by measuring the nitrate-nitrogen level in the 0-24 inch soil layer (map 2).
- On low or medium testing soils phosphorus or potassium should be applied before the deepest tillage operation.

Table 8. Phosphorus and potassium recommendations for sugarbeets

Nutrient	Soil fertility level			
	Low	Medium	High	Very high
	lbs/A			
Phosphorus — P_2O_5	150	100	50	20
Potassium — K_2O	150	100	50	0

Table 9. Nitrogen recommendations for sugarbeets

Previous crop	Amount of nitrogen to apply
	lbs/A
Corn, sugarbeets	100
Small grain, soybeans	80
Alfalfa, clover, black fallow	20

SUNFLOWERS

Fertilization Pointers

- Test soils to determine fertility status. Soils testing very high do not need broadcast application of P and K.
- Sunflower seeds are sensitive to salts; use no more than 10 pounds of $N+K_2O$ per acre in contact with the seed.
- Accuracy of nitrogen recommendations for sunflowers in western Minnesota is improved by a test of the 0-24 inch soil zone for nitrate-nitrogen content.

Table 10. Phosphorus and potassium recommendations for sunflowers

Nutrient	Soil fertility level			
	Low	Medium	High	Very high
	lbs/A			
Phosphorus — P_2O_5	60	40	10	0
Potassium — K_2O	60	40	10	0

Table 11. Nitrogen recommendations for sunflowers

Previous crop	Amount of nitrogen to apply
	lbs/A
Corn, sugarbeets,	80
Small grain, soybeans	60
Alfalfa, clover, black fallow	20

University Soil Tests

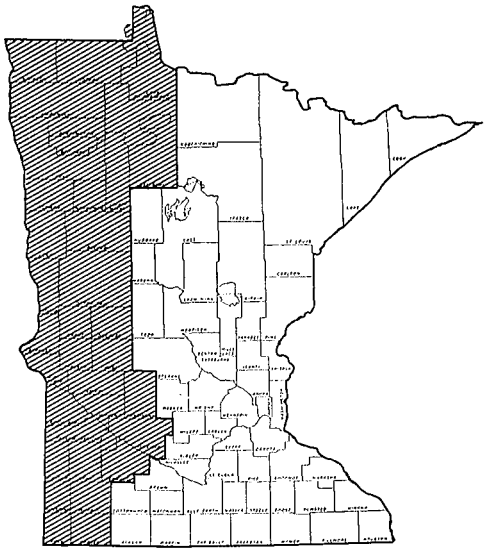
NITROGEN (N)

The ability of a soil to supply nitrogen is influenced by a variety of factors including total organic matter, soil moisture, soil temperature, cropping history, and residual fertilizer nitrogen. Since most soils do not have sufficient nitrogen supplying potential for satisfactory yields of nonleguminous crops, the nitrogen requirement of each crop must be carefully weighed against the calculated soil nitrogen supplied.

In western Minnesota the accuracy of nitrogen recommendations for small grain crops and sugarbeets can be improved by analyzing the soils for nitrate-nitrogen (NO_3-N) in the upper 2 feet of the soil profile. Because of this, a soil nitrate test is available for those desiring it (map 2). In other areas and for other crops, nitrogen recommendations are based on soil organic matter, cropping history, yield potential, and soil type.

Nitrogen recommendations based on a soil nitrate-nitrogen test apply only in western Minnesota (shaded area of map).

Map 2. Reference for nitrate test (shaded area)



Nitrogen recommendations based on nitrate-nitrogen in soil, if nitrogen test run.
Nitrogen recommendations not based on nitrate-nitrogen test.

To calculate how much nitrogen fertilizer to apply, subtract the soil test nitrate-nitrogen value from the appropriate crop given below and the difference is what should be applied per acre.

Crop	Total nitrogen needed lbs/A
Wheat (yield goal more than 60 bu/acre)	140
Wheat (yield goal 51 to 60 bu/acre)	120
Wheat (yield goal 41 to 50 bu/acre)	100
Wheat (yield goal under 40 bu/acre)	80
Oats, barley, millet, rye, and annual canary seed	100
Sugarbeets	170
Sunflowers	100

PHOSPHORUS (P)

Various soil factors including organic matter level, soil temperature, pH, and previous applications of manure or commercial fertilizers affect the availability of phosphorus. Map 1 illustrates the average phosphorus fertility status of Minnesota's soils based on soil test summaries. In a situation where a soil test is unavailable, the general fertility of soils in an area can be a guide.

The need for phosphorus is critical for most crops early in the growing season when plant demands in relation to root growth is high. These early season demands are often accentuated by wet or cold soil conditions which further restrict root development.

POTASSIUM (K)

Quantities and uptake of potassium in soils varies with soil texture, crop species, soil temperature, and relative quantities of soil calcium and magnesium. Map 1 is a guide to the general potassium fertility of various soil types in Minnesota.

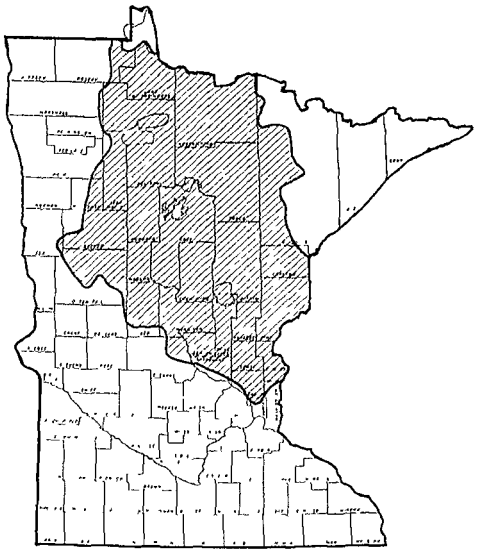
Crop demands for potassium are generally greatest midway through the growing season; however, crops growing on soils with low potassium levels respond to starter applications.

SULFUR (S)

Studies in Minnesota show that soils vary greatly in sulfur supplying capacities. Deficiencies most frequently occur on sandy, or low organic matter soils. Deficient areas are usually outside principal industrial sites. Most soils low in sulfur-supplying power are in north central Minnesota (map 3).

Not all soils in the nonshaded area are sulfur sufficient. However, extensive research indicates that a response to applied sulfur is extremely rare. Frequently, high subsoil sulfur levels are responsible for this lack of response; therefore, sulfur is recommended only on a trial basis if low sulfur tests are obtained in the nonshaded area.

Map 3. Approximate area (shaded) of highest probable sulfur-deficient soils



If extractable sulfur is less than 7 ppm (yield increase highly possible):

For alfalfa and clovers: At time of establishment, broadcast 50 pounds per acre of sulfur. This application would require 50 pounds of elemental sulfur or 300 pounds of gypsum (18 percent sulfur)/acre. Repeat application every 3 years

For corn and small grain: Broadcast 20 pounds per acre of sulfur or apply 10 pounds per acre of sulfur as starter. Repeat application every year.

If extractable sulfur is between 7 and 12 ppm (yield increase possible):

For alfalfa and clovers: Apply sulfur on a trial basis only If a response is noted, use recommendation here

For corn and small grain: no sulfur recommended.

If extractable sulfur is greater than 12 ppm (yield increase unlikely):

For alfalfa and clovers: no sulfur recommended.

For corn and small grain: no sulfur recommended.

ZINC (ZN)

Research indicates that deficiencies of zinc are almost always associated with a number of conditions including.

- soil pH — deficiencies are generally found on soils with a pH greater than 7.0.
- soil phosphorus content — zinc availability is greatly reduced by excess use of phosphorus fertilizers.
- preceding crop — if sugarbeets, the possibility of zinc deficiency increases.

- crop to be grown — field corn is the crop most likely to be zinc deficient in Minnesota.

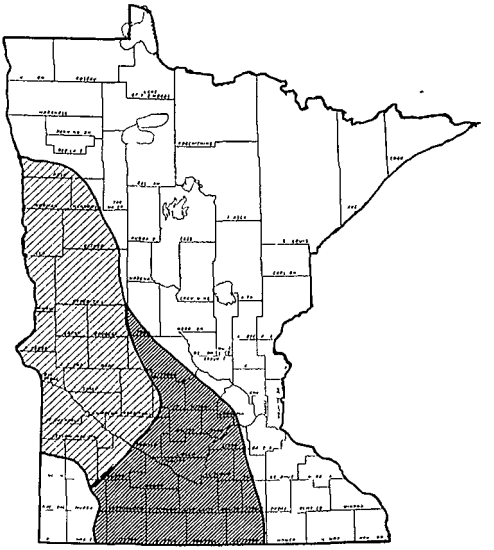
Map 4 shows the areas of Minnesota where zinc deficiencies occur most frequently. Deficiencies are easily controlled by applying 10 pounds of zinc per acre as zinc sulfate. One application should be sufficient for 2 to 4 years and is most effective when broadcast and plowed down. Zinc chelate and other zinc sources may be effective also, but may be more expensive.

Zinc soil test (ppm)	Relative level	Yield increase expected from zinc applications
Less than 0.5	Low	Highly possible
0.5 to 1.0	Medium	Possible
More than 1.0	High	Unlikely

ORGANIC MATTER

Research in Minnesota shows that organic matter levels are not consistently correlated with crop responses to fertilizer. However, knowing the percentage of organic matter in soils is useful in determining the proper rate of many herbicides. The percent organic matter will be determined by the University Soil Testing Laboratory on request.

Map 4. Zinc deficiency in Minnesota



Probable zinc-deficient area

Possible zinc-deficient area

Zinc deficiency unlikely

SOIL pH AND LIME RECOMMENDATIONS

Lime improves crops by promoting desirable biological activity and increased nutrient availability. Such benefits are realized through higher yields and better quality.

If alfalfa is part of the cropping rotation, pH levels of 6.5 or higher are desirable. If alfalfa is not in the rotation or if adequate lime is in the subsoil, pH levels of 6.0 or more are adequate.

Claims are sometimes made that an imbalance between calcium and magnesium is present in Minnesota soils. This leads to recommendations for calcitic limestone. No research data or sound theoretical concepts support this idea. Soils with a favorable pH, 6.0 or more will always contain adequate calcium and the use of calcitic rather than dolomitic limestone will not be beneficial.

Testing Fees

$3 regular series (pH, lime, P, K, O.M., texture) used for standard fertilizer and lime recommendations.

$2 nitrate test

$2 zinc test

$2 sulfur test

$1 soluble salt test

$1 pH and lime test only

$2 organic matter test

For further information or for submitting soil samples, contact the local county extension office or
Soil Testing Laboratory
1529 Gortner Ave.
University of Minnesota
St. Paul, MN 55108

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